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Nursing and Grow-Out of Hatchery-Reared Big Oyster (*Crassostrea belcheri* Sowerby 1871) in the Intertidal Mangrove Area

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ABSTRACT

The nursing of hatchery-reared juvenile oysters (*Crassostrea belcheri* Sowerby 1871) in the intertidal mangrove area was carried out over four months. The initial average width and length of the seed were both 2±0.05 mm, while average seed weight was 0.29±0.05 g. At the end of the experiment, the oyster seed reached 3.38±0.39 and 3.54±0.89 cm for average width and length, respectively and weighed an average of 3.22±2.01 g. The mean increase in daily growth rate of the shell width and length ranged from 0.13 to 0.29 and 0.12 to 0.38 mm/individual, respectively. The mean increase in live weight ranged from 0.16-0.39 g/individual. The mean survival rate was 22.52% at the end of the nursing experiment. For the grow-out experiment, oysters from the nursing experiment which were five cm or bigger were chosen and placed in flipping pouches in the intertidal zone for six months. At the end of this grow-out experiment, the mean increases in shell width and length were not significantly different among the treatments ($p>0.05$). However, there were significant differences in survival and in the amount of barnacle attachment among the treatments ($p<0.05$). A high survival rate was found with all densities after a five hour exposure to air at low tide during the spring tide period. The highest number of attached barnacles was found after an exposure to air of one hr at the lowest tide during spring tide.

Key words: nursing, growing, intertidal, mangrove, *Crassostrea belcheri* Sowerby 1871

INTRODUCTION

Thailand has abundant oyster resources from natural beds. The oyster beds are located in the shallow coastal waters of the intertidal mangrove areas. Oyster culture in Thailand was started in 1942. *Crassostrea belcheri* (Sowerby) is one of the most commercially important bivalves and many studies have been done on its biology and culture over many years (DOF, 1994). The natural distribution of this species is throughout estuarine waters. The species is tolerant to a wide range of salinities (Angell, 1986), a desirable characteristic for a species used in aquaculture. Its spat are always available, either naturally or from a hatchery. , *C. Belcheri* is mainly grown using natural seed, but the number of oyster seed from wild sources is limited and insufficient to supply grow-out farms. Oyster seed production from hatcheries has been continuously developed and is the subject of greater interest in Thailand than in Europe and North America (Tanyaros

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et al., 2000). Nursing of *C. Belcheri* spat produced from the hatchery is critical as it depends on several factors including quality of feed and water (Tantikulratana, 1990). Mangroves serve as valuable nursery areas for many fish and invertebrates (Aksornkoae, 1999). They also have a high potential for nursing and rearing hatchery-produced juvenile oysters. Only a few researchers have considered the feasibility of nursing hatchery-reared oyster seed in intertidal mangrove areas, although these habitats provide a rich source of food. Thus, a consideration of the potential for nursing and grow-out hatchery-reared big oyster in the intertidal mangrove area was the main purpose of this study.

MATERIALS AND METHODS

Study site

This study was conducted over a period of four months for nursing and six months for the grow-out at the Faculty of Science and Fishery Technology, Rajamangala University of Technology Srivijaya, Trang campus, located on the southern coast of the Andaman sea.

Nursing experiment

The experiments used *Crassostrea belcheri* seed produced from the Muka Head hatchery in Penang, Malaysia. The average length (anterior-posterior axis) of the seeds was two mm (SD = 0.5). The seeds were placed in nursing bags and tied to PVC frames (1.2 × 1.2 m). The PVC frames were made from 0.75 inch diameter PVC pipe. The nursing bags were divided into three types depending on mesh size: green bags had a mesh size of 0.5 mm, red bags had a mesh size of two mm, while the blue bags had a mesh size of five mm. The selected hatchery-reared seeds were initially put into the green bags. After two months, seed grading was done using sieves of 5 and 10 mm mesh sizes. Seeds smaller than five mm were put back into the green bags, while 5-10 mm seeds were put into the red bags and those bigger than 10 mm were put into the blue bags. Stocking densities of 200, 500 and 1,000 individuals per bag were used for the blue, red and green bags, respectively. There were four replicates of each stocking density. Thirty randomly collected oysters from each experimental nursing bag were taken at monthly intervals to measure shell length (anterior-posterior axis), width (dorsal-ventral axis) and weight. Dead individuals were counted to determine survival.

Grow-out experiment

The flipping pouch culture method was used for the grow-out of the oysters. These pouches were made from a plastic mesh with a size of 1 cm. The size of each pouch was 50 cm in width, 50 cm in length and 10 cm in depth. A piece of Styrofoam is a USA trademark for polystyrene was placed on top of each flipping pouch to cause the pouch to flip up during high tide. Oysters from the nursing experiment that were bigger than five cm (anterior-posterior axis) were used in this experiment. The oysters were put in the pouches at four densities ranging from 10 to 40 individuals per pouch, with four replicates used. The pouches were hung in the intertidal mangrove area at different air exposures from 0, 1, 3 and 5 hrs at low tide during spring tide. The experiment was set up using a 4 × 4 factorial in a completely randomized design (CRD) with each treatment of replications.

Statistical analysis

One-way ANOVA, with the experimental period as a factor was applied to the growth parameters (shell length, width and weight) and survival rate of the nursing experiment. Two-factor ANOVA, with density and time of a exposure to the air (hours) as factors was applied to the various growth parameters (shell length, width, and weight), survival rate and increase in fouling during the grow-out experiment. If significant

effects were present, the data was then subjected to Duncan's multiple range test to determine difference among treatment means.

RESULTS

Nursing experment

Hatchery-reared juvenile oysters were nursed in the intertidal mangrove area for four months. The initial mean values of shell width and length were both 2±0.05 mm, while the weight was 0.29±0.05 g. After 4 months of nursing, the mean shell width and length were 3.38±0.39 cm and 3.54±0.89 cm, respectively, while the mean weight was 3.22±2.01 g (Figures 1 and 2). There were significant differences (p<0.05) in the monthly mean growth rate of shell width and length, but no significant difference (p>0.05) was found in the monthly mean shell weight. The lowest mean growth rates of shell width and length were found in the third month of the experimental period. The mean growth rates in shell width were 0.29±0.11, 0.29±0.03, 0.13±0.03, and 0.29±0.09 mm/individual/day and shell length means were 0.30±0.11, 0.24±0.03, 0.12±0.03, and 0.38±0.14 mm/individual/day at the first, second, third and fourth month, respectively (Figure 3). The mean growth rates in shell weight were 0.18±0.11, 0.25±0.15, 0.16±0.10, and 0.39±0.15 g/individual/day in the first, second, third and fourth month,

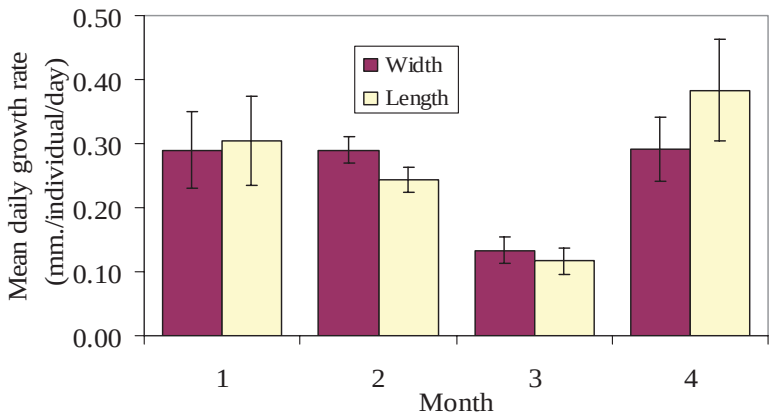

Figure 1 Cumulative growth of shell width and length of hatchery-reared seeds.

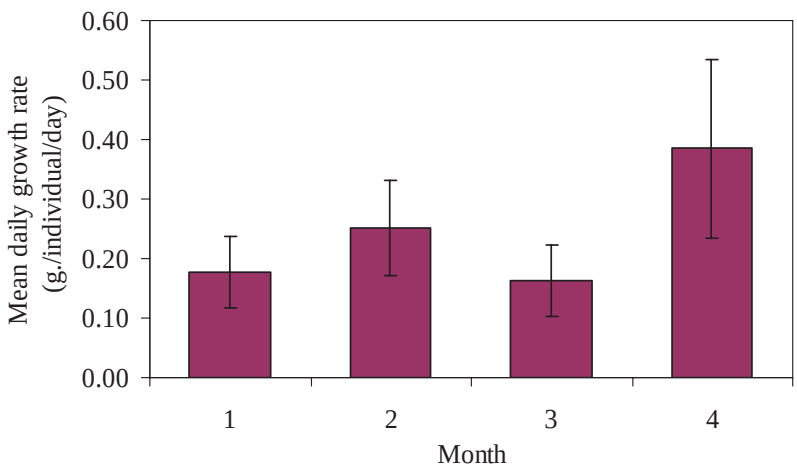

Figure 2 Cumulative growth of shell weight of hatchery-reared seeds.

respectively. (Figure 4). After four months the mean survival rate was 22.52%. (Figure 5).

Grow-out experiment

Oysters from the nursing experiment which were five cm or bigger were used for the grow-out experiment in flipping pouches in the intertidal zone. After six months, there were no significant differences in the increases in shell width and length among the treatments ($p>0.05$). Significant differences existed in the survival rates and the number of barnacles attached on the oyster shells among the treatments ($p<0.05$). The highest survival rate was found at stocking densities of 10 and 20 oysters/pouch with an exposure to the air of five hrs at low tide during spring tide, while the lowest survival rate was found in all stocking densities immersed in water. The highest number of barnacles attached on the oyster shells was found with an exposure to the air of one hr at low tide during spring tide when compared among treatments ($p<0.05$) as shown in Table 1.

DISCUSSION

Nursing experiment

Nursing hatchery-reared seeds of juvenile oysters in the intertidal mangrove area

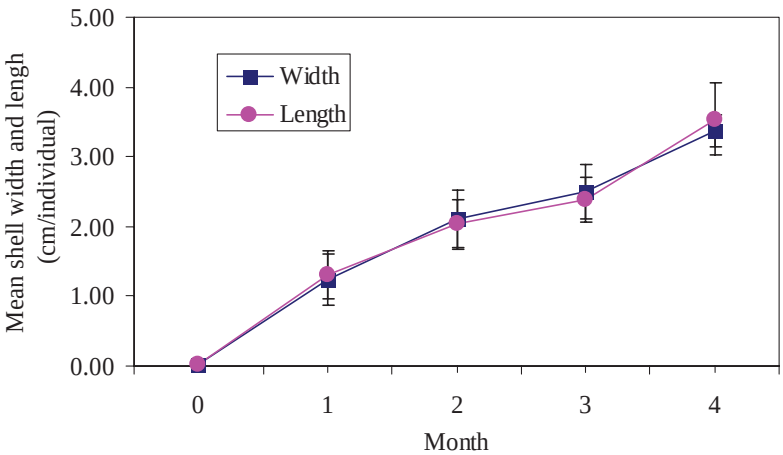

Figure 3 Mean growth rate of shell width and length of hatchery-reared seeds.

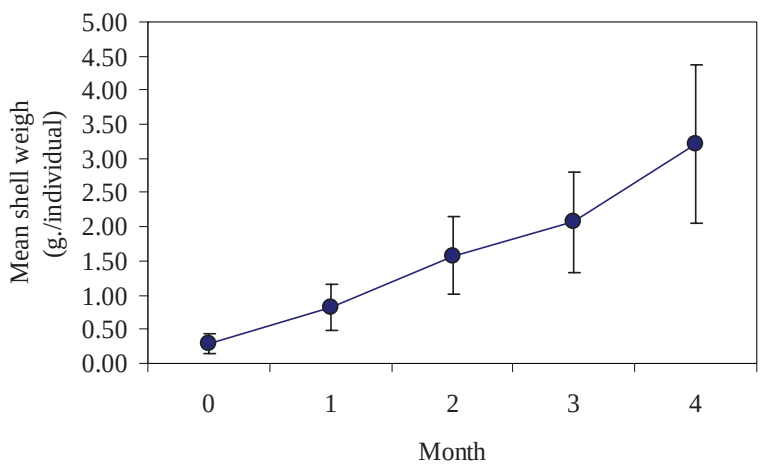

Figure 4 Mean growth rate of shell weight of hatchery-reared seeds.

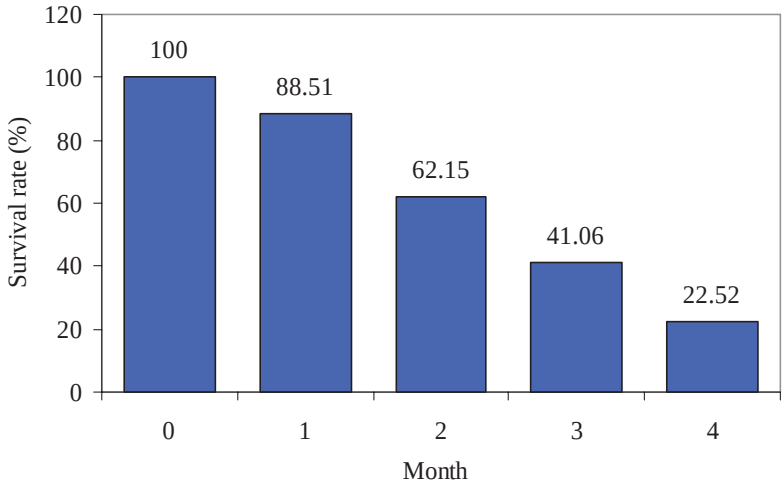

Figure 5 Mean survival rate of hatchery-reared seeds.

Table 1 Means of shell width, length, survival rate and number of attachment of barnacles on oysters grown at different stocking densities and air exposure over the culture period (six months).

Treatments	Width(cm)	Length(cm)	Survival rate (%)	Number of Barnacle attachment/individual
L1 × D1	7.0±0.5a	9.8±0.7a	56.6±2.5a	19±3a
L1 × D2	7.5±0.5a	9.4±0.6a	56.6±2.4a	10±4a
L1 × D3	7.7±0.6a	10.6±0.5a	64.4±4.2a	11±5a
L1 × D4	7.2±0.6a	10.6±0.7a	55.8±6.1a	5±8a
L2 × D1	8.0±0.4a	10.7±0.7a	73.3±2.1b	82±12b
L2 × D2	7.4±0.5a	9.9±0.6a	71.6±1.8b	61±8b
L2 × D3	7.5±0.5a	11.0±0.5a	72.2±2.6b	52±7b
L2 × D4	6.9±0.6a	10.3±0.5a	61.6±3.4a	21±6a
L3 × D1	7.2±0.4a	10.1±0.4a	86.6±2.1b	22+7a
L3 × D2	7.4±0.6a	10.4±0.5a	78.3±2.2b	9±8a
L3 × D3	7.6±0.6a	10.6±0.6a	76.6±1.8b	22±9a
L3 × D4	7.2±0.6a	10.5±0.5a	70.8±2.4b	25±9a
L4 × D1	7.6±0.6a	10.2±0.4a	90.0±1.8c	19±12a
L4 × D2	8.1±0.4a	10.4±0.4a	98.3±2.5c	16±8a
L4 × D3	7.4±0.4a	10.1±0.4a	83.3±1.9b	13±8a
L4 × D4	7.5±0.5a	9.9±0.5a	83.3±2.3b	9±5a

Remark : values designated by the same letter were considered to have non-significantly different means (p>0.05) by Duncan's multiple range test. Vertical comparison only.

L1 = Submerged in water; L2 = Exposure to air 1 hr during low tide at spring tide; L3 = exposure to air 3 hrs during low tide at spring tide; L4 = Exposure to air 5 hrs during low tide at spring tide

D1 = Stocking density at 10 oysters/pouch; D2 = Stocking density at 20 oysters/pouch

D3 = Stocking density at 30 oysters/pouch; D4 = Stocking density at 40 oysters/pouch

was carried out for four months. High growth and survival rates were obtained when compared with other experiments (Tantikulratana, 1990; Pinkaew and Srinual-adj, 1997). However, the growth and survival rates (22.5%) found in this experiment were rather low as a result of the small size of initial seeds used. The size of the oyster seed from settlement to three cm is the critical stage for nursing *C. Belcheri* (Sahavatcharin *et al*., 1990). The hatchery-reared seeds of juvenile oysters used in this experiment were smaller than five mm. In addition during the third month of the experiment, there was heavy rainfall and the water salinity dropped to less than 10 ppt. The tolerant oyster seeds remained, but low growth and survival rates were found during this time. These oysters (*C. belcheri*) are capable of tolerating a wide range of salinities both as larvae (12 to 24 ppt) (Tan and Wong, 1996) and as adults (10 to 35 ppt) (Titikulrattana and Wongviwattanavoot, 1984). Nevertheless, cultured oysters in the intertidal mangrove areas where there are fluctuations of salinity during the rainy season often are subjected to significant physiological impacts (Tirard *et al*. 1997). The response of the oysters to changes in the environmental salinity has been investigated by Hand and Stickle (1977). The results suggest a complex physiological change. A study of the oyster *C. virginica* found that changing the water salinity affected the sensitivity and activity of cilia and cirri on the ctenidia (Dean and Paparo, 1983). The oysters exposed to changing salinities showed very rapid valve movements and significant valve closure (Hand and Stickle, 1977). In addition, marine bivalves contain very high levels of free amino acids (FAA). An increase or decrease in salinity often results in an increase or decrease of FAA level in the tissues (Ellis *et al*., 1985). They are often monitored as a stress indicator in oysters such as *C. virginica* (Powell *et al*., 1982) and *C. gigas* (Lee *et al*., 2004). .

Grow-out experiment

There was low mortality in the oysters grown in flipping pouches at all stocking densities with an exposure to the air of five hrs at the lowest tide during spring tide. The survival rate of oysters from this study was higher than that of oysters grown on trays submerged beneath floating plastic pipe pontoons and grown on conventional intertidal trays as reported by Wisely *et al*., (1979) for *C. commercialis*. Low survival rates were found at all stocking densities submerged in water because of the colonisation of the submerged shells by aquatic organisms dominated by boring organisms (e.g. polychaetes and sponges), bryozoans and barnacles. Bio-fouling is a particular problem in bivalve culture resulting in reduced growth rates and survival (Taylor *et al*., 1997; Kaehler and McQuaid, 1999). Thus bio-fouling has to be addressed in oyster culture, given the relatively long culture period (Acosta-Salmon *et al*., 2004). A significantly high number of barnacles attached to the oyster shells was found with the exposure to the air of one hr at the lowest tide during spring tide when compared among treatments. The oyster exposure to sunshine during low tide affected the attachment of barnacles to the oysters. Increasing temperature had a direct effect on barnacle larval development (Thiyagarajan *et al*., 2003) and the ultraviolet radiation from sunshine has an indirect effect on the attachment of barnacles (Hung *et al*., 2005). The feasibility of heat treatment as an antifouling option has been studied (Rajagopal *et al*., 2005). In this experiment, it was observed that settlement of barnacles on the oyster shells increased with age in a way that was similar to the result reported by Guenther *et al*. (2006). The negative effects of bio-fouling on cultured oysters are minimised by regular manual cleaning, which contributes significantly to the operational expenses in oyster farming. Cleaning procedures are costly with regard to labour and equipment and may contribute up to 30% of the operational expenses in bivalve farming (Claereboudt *et al*., 1994). While the flipping pouch culture technique in this experiment was designed to minimize cleaning, the results

demonstrated that the loss of oysters increased significantly with age. These results implied that for oyster culture in the intertidal mangrove area using the flipping pouch culture technique, cleaning should occur every one or two weeks to reduce fouling, thereby increasing oyster production.

CONCLUSION

High growth and survival rates were obtained for nursing hatchery-reared seeds of juvenile big oysters in nursing bags in the intertidal mangrove area. Water salinity during nursing should be more than 12 ppt and the nursing bag should be cleaned frequently to counteract sedimentation. High survival occurred with oysters in flipping pouches with an exposure to the air of five hrs at the lowest tide during spring tides. Bio-fouling was a particular problem in the flipping pouch oyster culture technique.

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